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DISEASE SURVEY OF SMITH BUTTE

IN THE PLOUGH SALE AREA

MT. ADAMS RANGER DISTRICT

GIFFORD PINCHOT NATIONAL FOREST

WASHINGTON

DISEASE SURVEY OF SMITH BUTTE IN THE PLOUGH SALE AREA, MT. ADAMS RANGER DISTRICT, GIFFORD PINCHOT NATIONAL FOREST, WASHINGTON

by

Gregory M. Filip

Appreciation is extended to S. Worrell and B. Tkacz for assistance in field work, T. Gregg for computer analysis, and D. Goheen for manuscript review.

ABSTRACT

Approximately 100 acres of the Plough Sale Area, Mt. Adams Ranger District, were examined for disease-caused mortality. Wood loss as a result of tree mortality caused by root diseases alone averaged 35 ft^3/acre/year over the last 20 years. Although only 1% of the trees were infected by dwarf mistletoe, they represented 10% of the total volume. Important diseases included laminated root rot in grand fir and Douglas fir; Armillaria root rot in grand fir, Douglas-fir, ponderosa pine, and lodgepole pine; and dwarf mistletoe in Douglas-fir, western larch, and ponderosa pine. Management alternatives concerning these diseases are discussed.

Diseases reduce the annual productivity of Oregon and Washington forests by an estimated 403 million ft^3 (Childs and Shea 1967). This loss consists of 162 million ft^3 of growth loss, 129 million ft^3 of mortality, and 112 million ft^3 of cull. Most of the growth loss and mortality are caused by root diseases and dwarf mistletoes.

Root diseases are insidious, difficult to detect, and cause substantial damage in Pacific Northwest forests. On certain sites, losses can be dramatic. For example, loss through root disease-caused tree mortality has been estimated at 85 ft^3/acre/year in a stand in southern Oregon (Goheen 1980) and 75 ft^3/acre/year in a central Oregon forest (Filip 1980).

Dwarf mistletoes are easy to detect, not difficult to control silviculturally, but annually continue to cause mortality estimated at 72 million ft^3 in Oregon and Washington (Childs and Shea 1967). Losses are most severe in western larch and East Side Douglas-fir (Bolsinger 1978). Over 50% of the basal area growth can be reduced by severe infestations in larch and Douglas-fir (Pierce 1960).

District silviculturists, concerned by mortality apparently caused by diseases on Smith Butte in the proposed Plough Sale area, requested assistance of Forest Pest Management pathologists to aid in measuring disease-caused loss and formulating silvicultural prescriptions for the area. This report documents the results of a disease evaluation in this area.

OBJECTIVES

Objectives of this evaluation were to:

(1) determine stocking, volume, and basal area losses due to root diseases and other causes of mortality over 100 acres of the sale area;

(2) develop management alternatives based on data collected from the survey to reduce present and future mortality.

METHODS

The evaluation was done on Smith Butte (T. 7 N., R. 11 E., Sec. 19, 20, 29, 30) in the proposed Plough Sale (Fig. 1). The area surveyed contains stands that are primarily uneven-aged and are composed of several conifer species: grand fir (*Abies grandis*) and Douglas-fir (*Pseudotsuga menziesii*) predominate with lesser amounts of ponderosa pine (*Pinus ponderosa*), lodgepole pine (*P. contorta*), western white pine (*P. monticola*), and western larch (*Larix occidentalis*). Some sections within the area had been partially harvested, but most of the area had little evidence of past logging.

Variable-radius plots (BAF 40) were established every 2 chains along transects 5 chains apart. Data were collected for all trees on every fifth plot (measure plots) including a basal area count. For other plots (count plots), data were collected on root-diseased trees only along with a basal area count of all trees on the plot. Count plots with no evidence of root diseases were recorded as healthy. Only trees greater than or equal to 5.0 in. DBH were recorded.

The following data were collected for each plot tree: (1) species, (2) DBH (approximated for stumps), (3) height, (4) condition (living, dead, standing, down), and (5) cause of infection or mortality. Trees or stumps with less than half of their circumference at the root collar covered by intact bark were considered to have been dead for more than 20 years and were not recorded.

Root diseases were detected by chopping into trees at the root collar and by limited excavation and dissection of major roots. Only dead trees, symptomatic trees, or stumps were examined. Living but symptomless trees were not examined unless adjacent to an infected tree. Some living, symptomless trees might have been infected, especially grand fir with annosus butt rot or phellinus-tolerant species such as western larch, white pine, or lodgepole pine, with laminated root rot.

Laminated root rot caused by *Phellinus weirii* was detected by the presence of ectotrophic mycelium on the surface of exposed roots or by characteristic laminated decay with setal hyphae in old, dead material (Fig. 2). Armillaria root rot caused by *Armillaria mellea* was detected by the presence of mycelial fans beneath the bark (Fig. 3) or by yellow, stringy decay in old, dead material. Annosus root and butt rot caused by *Fomes annosus* was detected by the presence of white, stringy decay in old, dead material. No attempt was made to culture suspected pathogens.

From the collected data, mean basal area, number of trees, and volume per acre were calculated by tree species, DBH class, and condition using the Region 6, V-Plot computer program. Plot information was used to prepare a root disease distribution map.

RESULTS

Approximately 100 acres of the proposed Plough Sale were surveyed systematically with 154 variable plots (1.5 plots per acre). Forty-eight plots (31%) were infested with one or more root pathogens (Fig. 4). More plots probably were infested since entire root systems were not examined.

A mean of 37.5 trees per acre (12%) of a total of 305.4 trees per acre, representing 9% of the basal area, 9% of the cubic foot volume, and 8% of the board foot volume, was infected by root diseases (Table 1). Most of the infection was caused by *A. mellea* (Table 2). Root disease-caused mortality was distributed evenly among diameter classes (Table 3).

A mean of 2.9 trees per acre (1%), representing 7% of the basal area, 8% of the cubic foot volume, and 10% of the board foot volume, was infested by dwarf mistletoes (Table 1). Infection and mortality occurred primarily in larger diameter trees (Table 3).

Summary by species

1. Grand fir

Grand fir was the predominant species by stem count and basal area and was equal to Douglas-fir in volume (Table 1). Most of the grand fir mortality was caused by *A. mellea* (Table 2). Mortality caused by *P. weirii* was also high and often occurred in association with *A. mellea*. Grand fir is classified as highly susceptible to *P. weirii* (Hadfield and Johnson 1977). Mortality caused by *A. mellea* occurred in the smaller-diameter classes (many trees may have been suppressed or weakened by other factors) while *P. weirii* occurred primarily in larger trees (Table 3). Although not examined intensively, many trees probably have butt rot caused by *F. annosus*, especially trees with large, old wounds. Mortality associated with bark beetles (fir engravers-*Scolytus ventralis*) was always associated with root diseases. Although not common, a few trees outside of the plots were found infected by grand fir dwarf mistletoe (*Arceuthobium abietinum*). Although conks of the Indian Paint fungus (*Echinodontium tinctorium*) were not found on plot trees, grand fir is highly susceptible to infection and decay caused by this fungus, especially trees with large, old wounds.

2. Douglas-fir

Much of the stand volume is composed of old-growth Douglas-fir. Incidence of mortality caused by root diseases was less than that in grand fir (Table 1). Most of the root disease-associated mortality was caused by *P. weirii* (Table 2). Douglas-fir is classified as highly susceptible to *P. weirii*, but East Side Douglas-fir appears to be less susceptible than grand fir. Mortality associated with *A. mellea* also was common, especially in trees infected by dwarf mistletoe. Some *F. annosus* was found in stumps of harvested Douglas-fir.

Dwarf mistletoe (*A. douglasii*) was found on 5% of the Douglas-fir stems representing 16% of the board foot volume (Table 1), hence most of the damage occurred in larger-diameter trees (Table 3). Many of the infected trees apparently were killed by this pathogen.

Although mortality associated with bark beetles was not found in plots, the Douglas-fir beetle (*Dendroctonus pseudotsugae*) commonly infests old-growth trees, especially if weakened by other causes such as root diseases.

3. Ponderosa pine

Ponderosa pine occurs as scattered individual trees throughout the stand, a large percentage of which was infected and killed by *A. mellea*. A large infestation of *A. mellea* has been very damaging (35 ft^3/acre/year) in a predominantly ponderosa pine stand on St. Regis Paper Company land about 6 miles SE of Smith Butte (Shaw et al 1976). No infection by *P. weirii* or *F. annosus* was found in ponderosa pine. Ponderosa pine is classified as resistant to laminated root rot.

Some dwarf mistletoe (*A. campylopodum*) was found on ponderosa pine (2% of stems) primarily on large trees (18% of volume).

Although no bark beetles were found on dead plot trees, pines infected by root diseases often are attacked by mountain pine beetle (*D. ponderosae*) and western pine beetle (*D. brevicomis*).

Lodgepole pine

Lodgepole occurs in almost pure stands near the eastern base of Smith Butte. A high percentage of the infection by root pathogens was found in stumps of harvested trees (Table 1). Since all the infection was caused by *A. mellea*, it is likely that colonization occurred after tree removal. *Armillaria mellea* often further colonizes stumps following tree death or harvesting. Lodgepole is classified as tolerant to laminated root rot.

No bark beetles or dwarf mistletoe were found on lodgepole.

Western larch

Western larch occurs throughout the stand as scattered old-growth trees, some of which were killed by *P. weirii*, but not as high a proportion of larch as Douglas-fir or grand fir. Western larch is classified as intermediately susceptible to laminated root rot, often being "butt-rotted" rather than killed by the pathogen.

Larch dwarf mistletoe (*A. laricis*) was found in 20% of stems representing 19% of volume. Most of the infected trees were dead. As mentioned previously, growth loss in living, infected trees probably is severe.

White pine

White pine occurs in the stand as scattered individuals. Only trees killed by mountain pine beetle (*D. ponderosae*) were found in plots. These trees also may have had blister rust (*Cronartium ribicola*) although they were too deteriorated to tell. Infection and mortality caused by blister rust can be substantial as observed in other parts of the District. Mountain pine beetle also has caused severe losses in the past, especially on old-growth pine.

Dwarf mistletoe rarely is found on western white pine.

CONCLUSIONS AND RECOMMENDATIONS

Two disease problems are reducing productivity on Smith Butte: root diseases and dwarf mistletoes. Of the two, dwarf mistletoes are the easier to manage since they are not difficult to detect, spread slowly, and die with their hosts. Prescriptions aimed at removing infected old-growth trees and preventing spread from infected residuals to susceptible understory will reduce much of the loss.

Root diseases are more difficult to manage since they are not easy to detect and persist on the site even after host death. Practical management involves favoring of conifer species less susceptible to root disease and improving the vigor of the stand.

The following management alternatives for disease reduction are presented for the Plough Sale area in increasing order of cost and effectiveness of reducing diseases:

1. No treatment. Losses due to root disease-caused tree mortality should average 1.9 trees/acre/year, representing 35 ft^3/acre/year. This excludes growth loss of infected living trees and loss due to butt decay caused by root pathogens. Losses due to dwarf mistletoes and bark beetles will increase as trees become overmature.

2. Sanitation-salvage. Most of the wood loss sustained above will be captured, especially that caused by dwarf mistletoes and bark beetles. However, loss caused by root diseases will continue in the present stand, especially on the west side of the Butte.

3. Seed tree or shelterwood systems favoring western larch or white pine. Most of the merchantable timber will be harvested in one or a few operations. Future losses caused by root diseases will decrease since grand fir and Douglas-fir are most susceptible to laminated root rot and ponderosa pine to Armillaria root rot. In areas devoid of larch or white pine, Douglas-fir could be favored over grand fir or ponderosa pine. Loss of leave trees may be decreased even further if special care is taken to mark leave trees that are low risk to root diseases, based on their proximity to infected trees or stumps. Dwarf mistletoe-infected trees should be removed before susceptible understory reaches 3 feet tall or 10 years old, whichever occurs first. White pine and larch are not susceptible to Douglas-fir or ponderosa pine dwarf mistletoe (Hawksworth and Wiens 1972). If white pine is to be retained, care should be taken to select blister rust-free trees and remove trees before they reach 16 inches DBH or 120-140 years old to prevent mortality caused by mountain pine beetle.

4. Clearcutting and replanting. All of the merchantable timber will be harvested in one operation. Grand fir, ponderosa pine, and Douglas-fir should not be planted. Some reestablishment of these species will occur, but this can be minimized if units are large. Although some infection and mortality from root diseases will occur as the new stand matures, losses will be reduced if grand fir, Douglas-fir, and ponderosa pine are discriminated against. This alternative also is most effective in reducing dwarf mistletoes.

5. Seed tree, shelterwood, or clearcut systems with stump removal. This alternative will be the most effective in reducing infection and mortality caused by root diseases in residuals and regeneration, including grand fir, Douglas-fir, and ponderosa pine, and hence the future stand by removing the bulk of fungus inoculum from the soil (Roth et al 1977). However, steep topography will limit stump removal operations on Smith Butte.

The information and recommendations presented in this report have been specifically formulated for the area we examined. Although some of this information may be applied to other areas experiencing similar root disease problems, these areas may differ sufficiently from the area we surveyed to warrant a separate biological evaluation to formulate specific recommendations. Forest Pest Management pathologists encourage and are available to perform such evaluations at the request of land managers.

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Table 1--Relative frequencies of trees by species and condition within the Plough Sale Area

Species	Total	Healthy	Root Diseased				Bark Beetles	Dwarf Mistletoe
			Live	Dead	Harvested	Total	Dead	Live and Dead
Grand fir	239.9[a]	213.9	0.1	25.9	0	26.0(11)[e]	0.4[f]	0
	127.9[b]	115.7	0.3	11.9	0	12.2(10)	1.3	0
	3.8966[c]	3.5226	.0085	.3655	0	.3740(10)	.0532	0
	16.9058[d]	15.1361	.0457	1.7240	0	1.7697(10)	.3160	0
Douglas-fir	41.2	35.5	0.2	3.2	0.4	3.8(9)	0	1.9(5)
	80.7	65.1	0.3	3.6	1.0	4.9(6)	0	10.7(13)
	2.9053	2.3128	.0080	.1208	.0389	.1677(6)	0	.4248(15)
	16.9291	13.3738	.0375	.5756	.2450	.8581(5)	0	2.6972(16)
Ponderosa pine	16.2	9.7	0	5.5	0.6	6.1(38)	0	0.4(2)
	18.3	12.0	0	2.8	0.8	3.6(20)	0	2.7(15)
	.7444	.4941	0	.1066	.0235	.1301(17)	0	.1202(16)
	4.2782	2.8100	0	.5664	.1176	.6840(16)	0	.7842(18)
Lodgepole pine	4.1	2.7	0	0.7	0.7	1.4(34)	0	0
	4.0	2.7	0	0.3	1.0	1.3(33)	0	0
	.1140	.0819	0	.0042	.0279	.0321(28)	0	0
	.5178	.3826	0	.0001	.1352	.1352(26)	0	0
Western larch	3.0	2.2	0	0.2	0	0.2(7)	0	0.6(20)
	13.7	10.7	0	0.3	0	0.3(2)	0	2.7(20)
	.5866	.4653	0	.0096	0	.0096(2)	0	.1117(19)
	3.7102	2.9668	0	.0484	0	.0484(1)	0	.6950(19)
White pine	1.0	0	0	0	0	0	1.0	0
	1.3	0	0	0	0	0	1.3	0
	.0425	0	0	0	0	0	.0425	0
	.2072	0	0	0	0	0	.2072	0
Total	305.4	264.0	0.3	35.5	1.7	37.5(12)	1.4	2.9(1)
	245.9	206.2	0.6	28.9	2.8	22.3(9)	2.7	16.1(7)
	8.2894	6.8767	0.165	0.6067	.0903	.7135(9)	.0957	.6567(8)
	42.5483	34.6693	0.832	2.9144	.4978	3.4954(8)	.5232	4.1764(10)

[a] Trees per acre
[b] Basal area (ft^2) per acre
[c] M Cu. ft. per acre
[d] M. Bd. ft per acre
[e] Number in parentheses is percent of total
[f] All had root disease--not included in total

Table 2--Relative frequencies of root diseases by tree species and pathogens within the Plough Sale Area

Species	Total Root Diseased	*Phellinus weirii*	*Armillaria mellea*	*Fomes annosus*	*Phellinus* and *Armillaria*
Grand fir	26.0[a]	4.6	17.0	0	4.4
	12.2[b]	4.7	5.7	0	1.8
	.3740[c]	.1393	.1883	0	.0464
	1.7697[d]	.6713	.8849	0	.2135
Douglas-fir	3.8	2.0	1.2	0.2	0.4
	4.9	1.9	1.7	0.8	0.5
	.1677	.0618	.0538	.0303	.0218
	.8581	.2789	.2643	.1956	.1193
Ponderosa pine	6.1	0	6.1	0	0
	3.6	0	3.6	0	0
	.1301	0	.1301	0	0
	.6840	0	.6840	0	0
Lodgepole pine	1.4	0	1.4	0	0
	1.3	0	1.3	0	0
	.0321	0	.0321	0	0
	.1352	0	.1352	0	0
Western larch	0.2	0.2	0	0	0
	0.3	0.3	0	0	0
	.0096	.0096	0	0	0
	.0484	.0484	0	0	0
Total	37.5	6.8(18)[e]	25.7(68)	0.2(1)	4.8(13)
	22.3	6.9(31)	12.3(55)	0.8(4)	2.3(10)
	.7135	.2107(30)	.4043(56)	.0303(4)	.0682(10)
	3.4954	.9986(29)	1.9684(55)	.1956(6)	.3328(10)

[a] Trees per acre
[b] Basal area (ft^2) per acre
[c] M Cu.ft. per acre
[d] M Bd.ft. per acre
[e] Number in parentheses is percent of total

Table 3--Relative frequencies of trees by DBH class and condition within the Plough Sale Area

DBH class (in)	Total	Healthy	Root-Diseased				Bark Beetles	Dwarf Mistletoe
			Live	Dead	Harvested	Total	Dead	Live and Dead
	trees per acre							
4	109.3	91.5	0	17.8	0	17.8(16)[a]	0	0
8	76.8	68.8	0	8.0	0	8.0(10)	0	0
12	57.6	50.9	0	6.0	0.7	6.7(12)	0	0
16	33.5	29.6	0.2	1.9	0.8	2.9(9)	1.0	0
20	13.8	12.8	0.1	0.8	0.1	1.0(7)	0	0
24	4.2	3.4	0	0.3	0.1	0.4(10)	0.4[b]	0.4(10)
28	3.0	1.6	0	0.2	0	0.2(7)	0	1.2(40)
32	2.5	1.7	0	0.3	0	0.3(12)	0	0.5(20)
36	1.3	0.8	0	0.1	0	0.1(8)	0	0.4(31)
40	1.6	1.2	0	0.1	0	0.1(6)	0	0.3(19)
44	0.8	0.8	0	0	0	0	0	0
48	0.4	0.3	0	0	0	0	0	0.1(25)
52	0.5	0.5	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0
64	0.1	0.1	0	0	0	0	0	0
Total	305.4	264.0	0.3	35.5	1.7	37.5	1.4	2.9

[a] Number in parentheses is percent of total
[b] All had root disease - not included in total

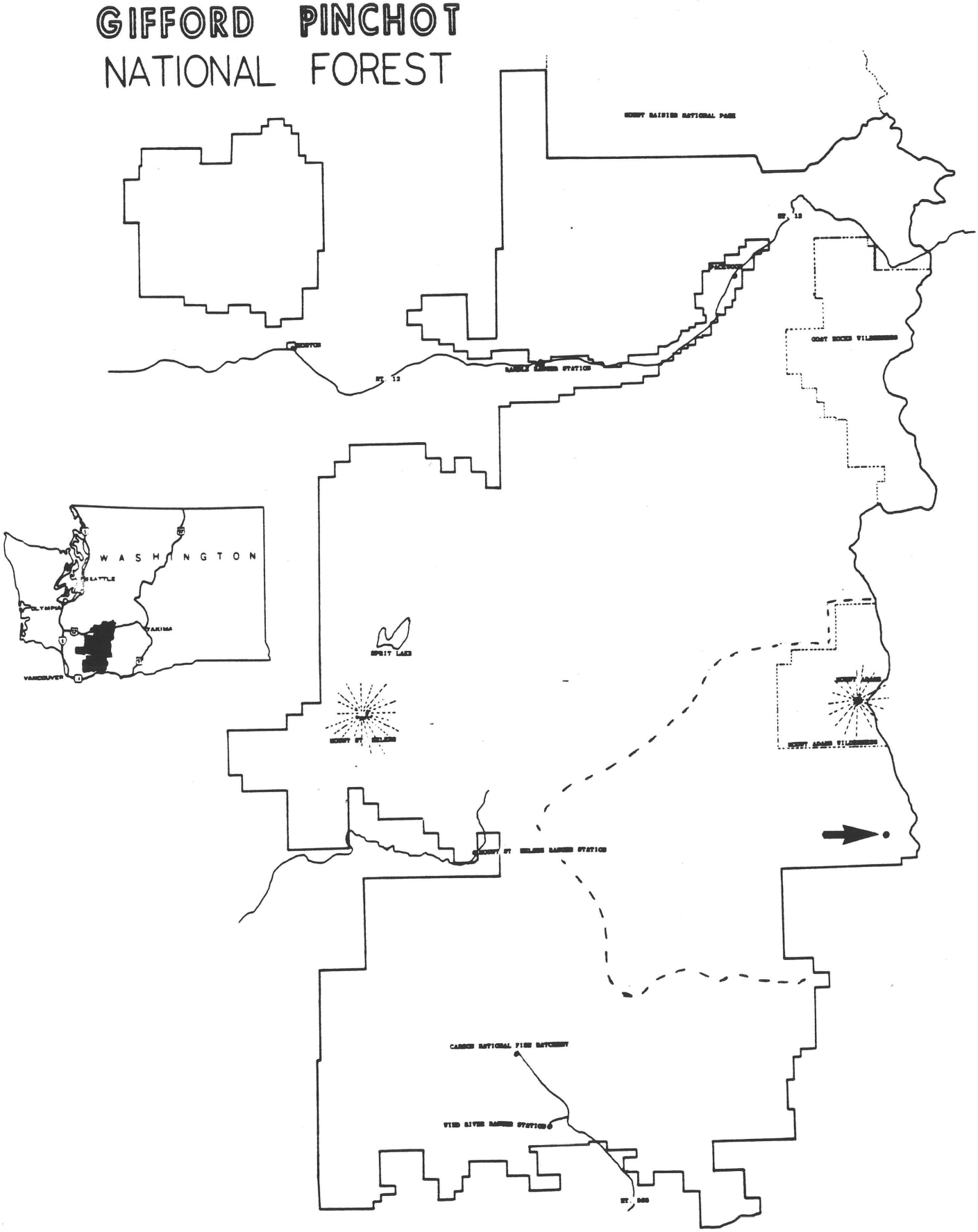
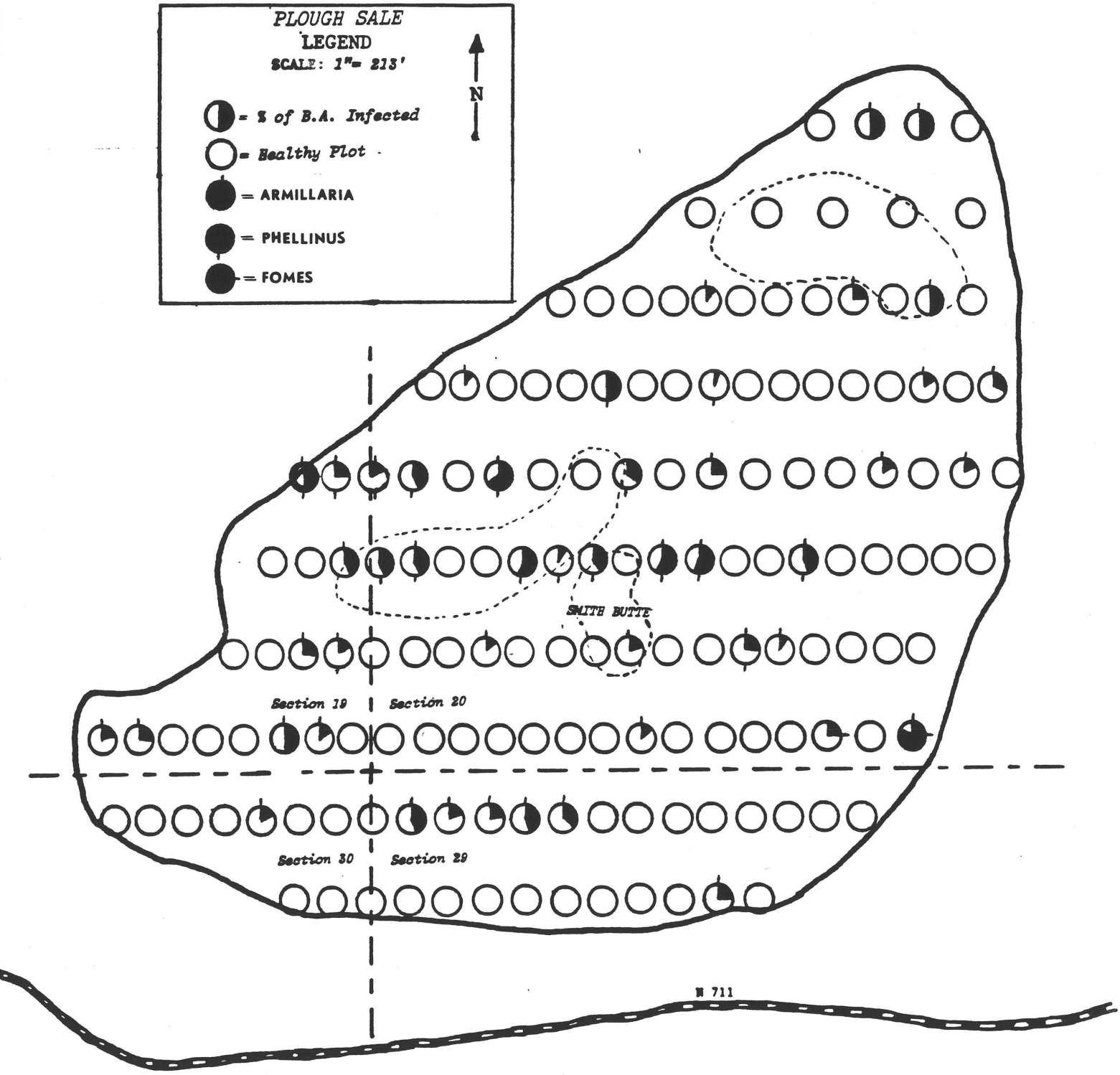


FIGURE 1. Map depicting area surveyed (arrow). Dotted line indicates northern, western and southern boundaries of the Mt. Adams Ranger District.

Fig. 2--Laminated decay of grand fir caused by *Phellinus weirii*

Fig. 3--Mycelial fan of *Armillaria mellea* on a dead ponderosa pine


PLOUGH SALE
LEGEND
SCALE: 1"= 213'
N
= % of B.A. Infected
= Healthy Plot
= ARMILLARIA
= PHELLINUS
= FOMES
SMITH BUTTE
Section 19
Section 20
Section 30
Section 29
M 711